REINFORCING BAR COUPLING

BACKGROUND OF THE INVENTION

Field Of The Invention

[0001] The invention is related to the field of devices and methods for coupling reinforcing bars.

Description Of The Related Art

[0002] In steel reinforced concrete construction, there are generally three types of splices or connections; namely lap splices; mechanical splices; and welding. Probably the most common is the lap splice where two bar ends are lapped side-by-side and wire tied together. The bar ends are of course axially offset which creates design problems, and eccentric loading whether compressive or tensile from bar-to-bar. Welding is suitable for some bar steels but not for others and the heat may actually weaken some bars. Done correctly, it requires great skill and is expensive. Mechanical splices normally require a bar end preparation or treatment such as threading, upsetting or both. They also may require careful torquing.

[0003] Improvements are continually being sought in mechanical splices and splicing methods, for instance to improve performance, cost, and/or ease of installation.

SUMMARY OF THE INVENTION

[0004] According to an aspect of the invention, a reinforcing bar splice for joining reinforcing bars, includes: a sleeve segment having longitudinal integral ribs deforming to conform to deformations on the reinforcing bars when the sleeve segment and the bars are relatively pressed together; and a clamp operatively configured to relatively press the sleeve segment and the bars together.

[0005] According to another aspect of the invention, a splice for deformed reinforcing bar includes a sleeve segment having longitudinal ribs on an inner surface; and means to clamp the sleeve segment against an end of the deformed bar to cause the ribs to deform to conform to and lock the deformed bar.

[0006] According to yet another aspect of the invention, a splice for deformed reinforcing bar includes: a sleeve segment having a deformable interior section

weaker than the balance of the segment; and means to press the weaker interior section against the bar to cause it to conform to and lock with the deformed bar.

[0007] According to still another aspect of the invention, a method of splicing reinforcing bars having deformations thereupon, includes the steps of: placing longitudinal ribs of a sleeve section against ends of the bars; and pressing the longitudinal ribs onto the bars, causing them to conform to the bar deformations.

[0008] To the accomplishment of the foregoing and related ends, the invention comprises the features hereinafter fully described and particularly pointed out in the claims. The following description and the annexed drawings set forth in detail certain illustrative embodiments of the invention. These embodiments are indicative, however, of but a few of the various ways in which the principles of the invention may be employed. Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0009] In the annexed drawings, which are not necessarily to scale:

[0010] Fig. 1 is an oblique view of a splice of the present invention;

[0011] Fig. 2 is an exploded view of some parts of the splice of Fig. 1;

[0012] Fig. 3 is an enlarged cutaway side view partly in section, of part of the splice of Fig. 1, illustrating the locking between ribs and a reinforcing bar;

[0013] Fig. 4 is an end view showing a sleeve section of the splice of Fig. 1, with undeformed ribs;

[0014] Fig. 5 is an end view showing a sleeve section of the splice of Fig. 1, with partially-deformed ribs;

[0015] Fig. 6 is an end view showing a sleeve section of the splice of Fig. 1, with fully-deformed ribs;

[0016] Fig. 7 is an oblique view of a sleeve section according to one embodiment of the present invention;

[0017] Fig. 8 is an enlarged end view of the sleeve section of Fig. 7;

[0018] Fig. 9 is a side view of the sleeve section of Fig. 7;

[0019] Fig. 10 is a view of the sleeve section seen from the bottom of Fig. 9;

[0020] Fig. 11 is an oblique view illustrating sleeve sections of Fig. 7 as part of a splice;

[0021] Fig. 12 is an oblique view of another embodiment of a splice in accordance with the present invention;

[0022] Fig. 13 is an end view of the splice of Fig. 12;

[0023] Fig. 14 is a cutaway side view of the splice of Fig. 12;

[0024] Fig. 15 is an exploded view illustrating details of some of the parts of the splice of Fig. 12;

[0025] Fig. 16 is an end view illustrating one variation of the splice of Figs. 12-15;

[0026] Fig. 17 is an end view illustrating another variation of the splice of Figs. 12-15;

[0027] Fig. 18 is an oblique view of an embodiment of a sleeve of the present invention, having an integral sleeve segment with integral longitudinal ribs;

[0028] Fig. 19 is an end view of the sleeve of Fig. 18;

[0029] Fig. 20 is an oblique view of yet another embodiment of a splice in accordance with the present invention;

[0030] Fig. 21 is an end view of the splice of Fig. 20;

[0031] Fig. 22 is a cutaway side view of the splice of Fig. 20;

[0032] Fig. 23 is an oblique view of still another embodiment of a splice in accordance with the present invention;

[0033] Fig. 24 is a cutaway side view of the splice of Fig. 23;

[0034] Fig. 25 is an end view of the splice of Fig. 23;

[0035] Fig. 26 is a side view of a further embodiment of a splice in accordance with the present invention;

[0036] Fig. 27 is an oblique view of a sleeve segment for use in the splice of Fig. 26;

[0037] Fig. 28 is an end view of the sleeve segment of Fig. 27;

[0038] Fig. 29 is a side view if the splice of Fig. 26, showing the splice prior to engagement of the fingers of the sleeve portions;

[0039] Fig. 30 is an oblique view of a still further embodiment of a splice in accordance with the present invention; and

[0040] Fig. 31 is an end view of a sleeve that is part of the splice of Fig. 30.

DETAILED DESCRIPTION

[0041] A reinforcing bar coupling includes a sleeve segment having a deformable interior section weaker than the balance of the segment. The deformable interior section, for example including deformable ribs, is configured to be pressed onto ends of reinforcing bars to be spliced together. The ribs deform onto and around deformations on exterior surfaces on the ends of the reinforcing bars. Thus secured to the ends of the reinforcing bars under pressure, the sleeve segment secures the ends of the reinforcing bars together. The sleeve segment may take any of a variety of forms, such as an insert placed inside a sleeve, or a portion of a sleeve, between the sleeve or portion, and the reinforcing bar. The clamp used to press the sleeve segment onto the reinforcing bar ends may also have a variety of forms, such as bolts contacting the reinforcing bar ends or an insert, bolts arranged to squeeze ends of a sleeve together, tapered collars that engage outer surfaces of one or more sleeve segment, or fingered collars that press inward against the sleeve segment.

[0042] Fig. 1 shows the generalized configuration of a reinforcing bar splice 10, for splicing together reinforcing bars 12 and 14 (also referred to herein as "bar ends"). The splice 10 includes a sleeve segment 16 and a clamp 18. The term "sleeve segment," as used herein, refers to at least a portion of a curved sleeve, such as would partially or wholly circumferentially engage and surround a cylindrical object, such as an annulet may engage and surround a column. A sleeve segment, as the term is used herein, may completely circumferentially surround a cylindrical object, such as a reinforcing bar. Alternatively, a sleeve segment may be along only a circumferential portion of the cylindrical object. A sleeve segment has a curved inner surface for engaging the cylindrical object. The outer surface of a sleeve section may also be curved, but does not need to be curved. A sleeve segment may be a separate item, or may be a unitary and integral part of a sleeve that fully circumferentially surrounds the object.

[0043] The sleeve segment 16 includes a deformable inner section, which for instance, includes a plurality of longitudinal (axial) ribs 24. The clamp 18, which may include a sleeve 26, presses the sleeve segment 16 against the bar ends 12 and 14. The deformable inner section 20 of the sleeve segment 16 deforms to conform to the

shape of the bar ends, and in particular to deformations 32 and 34 on the respective bar ends 12 and 14.

[0044] This conforming is illustrated in Figs. 2 and 3, which show deformation of the ribs 24 at various locations 36 along an inner surface 38 of the sleeve segment 16. The locations 36 correspond to the deformations 32 and 34 in the bar ends 12 and 14. The ribs 24 may also be somewhat flattened and pressed onto the bar ends 12 and 14 at other locations along the bar ends 12 and 14, i.e., locations where the bar ends 12 and 14 do not have deformations 32 and 34.

[0045] It will be appreciated that by deforming the deformable inner section 20 (and the ribs 24) of the sleeve segment 16, and by maintaining pressure to keep the sleeve segment 16 in contact with the bar ends 12 and 14, a strong splice may be made between the bar ends 12 and 14. The ribs 24, for example, provide great strength and a great deal of resistance to pulling out of the bar ends 12 and 14 from the splice 10. With the ribs 24 deformed and the sleeve segment 16 pressed against and onto the bar ends 12 and 14 by the clamp 18, the sleeve segment is locked onto the bar ends 12 and 14, thereby splicing the bars together.

[0046] The deformable inner section 20 of the sleeve segment 16 may be made of a material that is softer, more malleable, and/or has a greater ductility than the material of the bar ends 12 and 14. Examples of suitable materials for the sleeve segments 16 are 1117 steel and 1020 steel. It will be appreciated that other suitable materials may be utilized which have a hardness which is less than the hardness of the reinforcing bar ends 12 and 14. Standard reinforcing bars have a hardness of about 12-15 HRC (about 210 Brinnell-mm ball).

[0047] The sleeve segment 16 may have uniform material properties, such as a uniform hardness, malleability, and ductility throughout. Alternatively, it will be appreciated that some portions of the sleeve segment 16 may have different properties than other portions. For example, the deformable inner section 20 may be softer than an outer section 40 of the sleeve segment 16. This may be

accomplished, for instance, by flame treating or otherwise treating the outer sections 40 to increase the hardness of the outer section 40.

[0048]The splice 10 shown in Fig. 1 is only a generalized illustration. As will be described in greater detail below, the sleeve segment 16 and the clamp 18 may have a wide variety of various forms. For example, the sleeve segment 16 may be a separate insert placed within one or more sleeves or collars, placed between the rebar ends 12 and 14 and inner surfaces of the sleeves or collars. Alternatively, the sleeve segment 16 with the ribs 24 or other deformable inner section 20 may itself be a part of a sleeve that surrounds the bar ends 12 and 14. There may be one sleeve segment 16 or multiple such segments.

[0049]The clamp 18 may be one or more sleeves or collars that press inward on the sleeve segment 16. Alternatively or in addition the clamp 18 may include one or more bolts that press against the sleeve segment 16, the bar ends 12 and 14, or an additional insert. As a further alternative, the clamp 18 may include deformed sections of the sleeve segment 16, utilizing methods such as crimping to permanently deform entire sections of the sleeve segment 16, thereby deforming the ribs 24 or other deformable inner section 20 of the sleeve 16, and maintaining pressure of the sleeve section 16 after the crimping operation is completed.

[0050]Fig. 4 shows details of one embodiment of the ribs 24. As shown, the ribs 24 have a crenellated shape, although it will be appreciated that the ribs 24 may have a different shape. The ribs 24 each have distal top portions 44, farther from a sleeve segment body 46 than proximate bottom portions 48 of the ribs 24. There are troughs 50 between adjacent of the ribs 24. The top portion 44 of a rib 24 has radiused corners 52 and 54. Similarly, the bottom portion 48 has radiused corners 56 and 58 where the rib 24 joins to the sleeve segment body 46, on either side of the rib 24. The radiused corners 52, 54, 56 and 58 may prevent or inhibit cracking of the ribs 24, such as by reducing stress concentration points or stress risers in the ribs 24.

[0051]Figs. 5 and 6 show examples of deformation of the ribs 24 when the sleeve segment 16 is pressed onto the bar ends 12 and 14 by the clamp 18. Fig. 5 shows a relatively modest level of deformation, such as may occur in an area corresponding to an area of one of the bars 12 and 14 that does not include deformations 32 and

34. In the configuration shown in Fig. 5 the top portions 44 of the ribs 24 are somewhat flattened, reducing the distance between adjacent of the top portions 44 in the troughs 50. The spacing in the troughs 50 between the bottom portions 48 of adjacent of the ribs 24 may be substantially unchanged by the deforming process, or alternatively may be reduced somewhat, but by less than the spacing reduction between the top portions 44.

[0052] Fig. 6 illustrates a more pronounced deformation of the ribs 24. The configuration shown in Fig. 6 may occur in an area of the inner surface of the sleeve segment 16 corresponding to the deformations 32 and 34. The top portions 44 of the ribs 24 are sufficiently flattened so as to substantially close off the tops of the troughs 50. The top portions 44 may thereby come into contact with one another. Again, as with the configuration shown in Fig. 5, the distance between the bottom portions 48 of the ribs 24 may be substantially unchanged, or may be reduced somewhat without causing contact between the bottom portions 48 of adjacent of the ribs 24.

[0053] What follows now are descriptions of various particular embodiments of the splice 10. These various illustrative embodiments provide some idea of the great range of configurations that may utilize the deformable longitudinal (axial) ribs 24 or other deformable inner section 20.

[0054] Figs. 7-10 illustrate a sleeve section 116 that has a sleeve section body 118 having tapered outer surfaces 120 and 122. The sleeve section wall or body 118 has notches 126, 128, and 130 therein. Troughs 132 between adjacent of the ribs 124 provide thinned hinged points 136, 138, and 140, at which elements or sections 142, 144, 146, and 148, can pivot relative to one another. It should be noted that a trough 132 between adjacent of the ribs 124 does not necessarily correspond in location to each of the notches 126, 128, and 130.

[0055] The taper of the tapered outer surfaces 120 and 122 may be between about 1 and about 5 degrees. The sleeve segments 116 may have an overall extent of about 125 to about 150 degrees.

[0056] With reference now in addition to Fig. 11, a clamp 168 is used to clamp the sleeve section 116 and an additional sleeve section 176 to reinforcing bar ends 182 and 184, to form a splice 185. The clamp 168 includes a pair of tapered collars 186

and 188. The tapered collars 186 and 188 have tapered inner surfaces, such as the inner surface 190 of the collar 186. The tapered inner surfaces correspond to and interact with the tapered outer surfaces 120 and 122 of the sleeve sections 116 and 176. The tapered collars 186 and 188 may be driven onto the sleeve sections 116 and 176 with an appropriate tool. Axial force from the collars 186 and 188 result in a radial inward force on the sleeve sections 116 and 176, driving the sleeve sections 116 and 176 toward and onto the reinforcing bar ends 182 and 184. This may deform the ribs 124, especially conforming them to deformations on the reinforcing bar ends 182 and 184. Further details regarding suitable collars and tools may be found in U.S. Application No. 10/155,551, filed January 23, 2002; in U.S. Application No. 10/055,399, filed January 23, 2002; and in a concurrently-filed application, Attorney Docket No. ERICP0326USB, titled "Reinforcing Bar Connection and Method." All of these applications are hereby incorporated by reference in their entirety.

[0057] Turning now to Figs. 12-14, a splice 210 for coupling together reinforcing bar ends 212 and 214 is shown. The splice 210 includes a clamp 218 for clamping a pair of sleeve segments 220 and 222 into and/or onto the bar ends 212 and 214. The clamp 218 includes a sleeve 226 into which the sleeve segments 220 and 222 are inserted. The sleeve 226 has a plurality of radially-oriented protrusions 230, each of which has a threaded hole therein for receiving one of a plurality of bolts or jack screws 232. The bolts 232 may be shear bolts, which have heads that shear off when a certain level of torque is reached. The bolts 232 press down onto the upper sleeve segment 220, pressing the upper sleeve segment 220 into or onto the bar ends 212 and 214, and pressing the bar ends 212 and 214 into or onto the lower sleeve segment 222. The use of shear bolts as the bolts 232 controls the amount of force that is used in pressing the sleeve segments 220 and 222 onto the bar ends 212 and 214. In addition, the use of shear bolts as the bolts 232 reduces the level by which the bolts 232 protrude from the protrusions 230 of the sleeve 226, after installation is complete.

[0058] As best shown in Fig. 13, the lower sleeve segment 222 may have a greater circumferential extent than the upper sleeve segment 220. However, it will be appreciated that alternatively the sleeve segments 220 and 222 may have

substantially identical circumferential extent, or that the upper sleeve segment 220 may have a greater circumferential extent than the lower sleeve segment 222.

[0059] With reference now to Fig. 15 the lower sleeve segment 222 has longitudinal ribs 234 thereupon. The ribs 234 are designed to be deformed when pressed onto the bar ends 212 and 214, in a manner similar to that described with regard to other embodiments. The upper sleeve segment 220 has circumferential teeth 238 thereupon. The teeth 238 are designed to bite into the bar ends 212 and 214, thus securing the tops of the bar ends 212 and 214.

[0060] In addition, the lower sleeve segment 222 may have axial teeth 240 on an outer surface 242 thereof. The axial teeth 240 may bite into a bottom part of the sleeve 226, thus preventing sliding of the lower sleeve segment 222 relative to the sleeve 226. The outer surface axial teeth 240 of the lower sleeve segment 222, and the inner surface axial teeth 238 of the upper sleeve segment 220, will in general be harder than the portions of the splice 210 which they contact. That is, the axial teeth 238 of the upper sleeve segment 220 will in general be harder than the material of the bar ends 212 and 214. The outer axial teeth 240 of the lower sleeve segment 222 may be harder than the bottom portion of the sleeve 226. This facilitates biting of the axial teeth 238 and 240 in the respective surfaces that they contact.

[0061] Many variations are possible regarding the securement of the upper sleeve segment 220 to the bar ends 212 and 214, and the securement of the lower sleeve segment 222 to the sleeve 226. For either or both securements, it will be appreciated that the axial teeth shown may be omitted.

[0062] Other variations are illustrated in Figs. 16 and 17. Referring to Fig. 16, according to one variation, an upper sleeve segment 250 has longitudinal (axial) ribs thereupon, and a lower sleeve segment 256 has axial teeth on an inner surface thereof. In another variation, illustrated in Fig. 17, both an upper sleeve segment 260 and a lower sleeve segment 262 may have respective sets of longitudinal ribs thereupon.

[0063] It will further be appreciated that it may be possible to omit the upper sleeve segment 220 entirely, with the bolts 232 directly engaging the bar ends 212 and 214.

[0064] As shown in the Fig. 12, the bolts 232 are substantially in a single line along the axis of the bar ends 212 and 214. It will be appreciated that alternatively, the

protrusions 230 and the bolts 232 may be other than in a single line, for example, being in a zigzag configuration, perhaps used in conjunction with a wider (larger circumferential extent) upper sleeve segment 220. Such arrangement may allow for a shorter sleeve 226, while still providing sufficient force to maintain the bar ends 212 and 214 engaged in the splice 210.

[0065] As another alternative, it will be appreciated that three or more sleeve segments may be utilized. Some or all of the sleeve segments may have a longitudinal ribs or other deformable elements for being pressed onto and engaging the bar ends 212 and 214.

[0066] Figs. 18 and 19 show an alternative sleeve 320 that includes, as an integral part, a sleeve segment 322 having ribs 324 formed thereupon. The sleeve 320 includes a protrusion 330 having a number of bolt holes 332 for receiving suitable bolts, such as the shear bolts discussed above. The sleeve 320 may be formed for example by extrusion. It will be appreciated that the sleeve 320 may be incorporated into splice 210 described above, with for example, the sleeve 320 replacing the sleeve 226 and the lower sleeve segment 222. External parts of the sleeve 320 may be flame treated or otherwise hardened, leaving the longitudinal ribs 324 softer than other parts of the sleeve 320.

[0067] Turning now to Figs. 20-22, a splice 410 is illustrated coupling together bar ends 412 and 414. The splice 410 has a clamp 418 for pressing sleeve segments 420 and 422 onto and/or into the bar ends 412. The clamp 418 includes a C-shaped sleeve 426, and bolts 432 that pass through bolt holes 434 in flanges 436 and 438 of the sleeve 426. The upper flange 436 has smooth holes, and the lower flange 438 has threaded holes. As one of the bolts 432 is screwed into the threads of the holes 434, the flanges 436 and 438 are subject to an increasing tightening force. This constricts the cylindrical portion of the sleeve 426, providing a pressing force on the sleeve segments 420 and 422 against the bar ends 412 and 414. One or both of the sleeve segments 420 and 422 may have deformable longitudinal ribs thereupon, the operation of which has been described above with regard to other embodiments. The sleeve 426 may be made of a variety of suitable materials, such as suitable steels, that have sufficient flexibility for pressing against the sleeve sections 420 and 422.

[0068] Turning now to Figs. 23-25, a splice 510 is shown that includes a clamp 518 for pressing sleeve segments 520 and 522 onto and/or into reinforcing bar ends 512 and 514. The sleeve segments 520 and 522 may be similar to the sleeve segments discussed above. The sleeve 526 includes an upper sleeve half 528 and a lower sleeve half 530. The upper sleeve half 528 has a pair of rows of through-holes 532 on opposite diametric sides of the bar ends 512 and 514. The lower sleeve half 530 includes a corresponding array of threaded holes 534. The holes 532 and 534 are aligned, and are configured to receive a plurality of bolts 536 to securely clamp the sleeve halves 528 and 530 together, thereby pressing the sleeve segments 520 and 522 inward to engage the bar ends 512 and 514.

[0069] With reference now to Figs. 26-29, a splice 610 includes a clamp 618 that has a pair of fingered sleeves 620 and 622 that press inward against a ribbed sleeve section 626. This inward pressing of the sleeve section 626 engages the sleeve section 626 with reinforcing bar ends 612 and 614. With particular reference to Figs. 27 and 28, the sleeve segment 626 has multiple hinged sections 640, with outer wall notches 642 between the sections. Along an inner surface of the sleeve segment 626 are a series of longitudinal (axial) deformable ribs 644.

[0070] The sleeves 620 and 622 have respective sets of fingers 650 and 652, as is best shown in Fig. 29. The fingers 650 and 652 have angled surfaces. When the sleeves 620 and 622 are slid toward one another from opposite sides of the splice 610, the fingers 650 and 652 interlace or interdigitate, as shown in Fig. 26. The fingers of each of the sleeves slide under the unfingered portion of the other sleeve, and are pressed inward as the sleeves 620 and 622 are pushed together. The inward pressure is transmitted to the sleeve segment 626, which presses in upon the bar ends 612 and 614, thereby deforming portions of the longitudinal ribs 644.

[0071] Fig. 30 shows the splice 710 that involves cold-swaging or crimping portions of an internally ribbed sleeve 720 to couple together reinforcing bars 712 and 714. With reference to Fig. 31, sleeve 720 has ribs 724 along its internal surface. The cold-swaged or crimped portions, which are indicated in Fig. 30 by reference number 730, are portions that are pressed inward by use of a suitable tool, such as a portable hydraulic press with special dies. It will be appreciated that the cold-swaging operation may be accomplished with less tool force than in previous cold-

swaged couplers, due to the relatively soft material of the sleeve 720 that is employed. Rather than needing to cold-swage or crimp a hard steel sleeve, the relatively soft steel of the sleeve 720 and in particular the ribs 724, need only be deformed. It will be appreciated that the configuration and placement of the swaged areas 730 may take any of a wide variety of suitable shapes and configurations.

[0072] Although the invention has been shown and described with respect to a certain preferred embodiment or embodiments, it is obvious that equivalent alterations and modifications will occur to others skilled in the art upon the reading and understanding of this specification and the annexed drawings. In particular regard to the various functions performed by the above described elements (components, assemblies, devices, compositions, etc.), the terms (including a reference to a "means") used to describe such elements are intended to correspond, unless otherwise indicated, to any element which performs the specified function of the described element (i.e., that is functionally equivalent), even though not structurally equivalent to the disclosed structure which performs the function in the herein illustrated exemplary embodiment or embodiments of the invention. In addition, while a particular feature of the invention may have been described above with respect to only one or more of several illustrated embodiments, such feature may be combined with one or more other features of the other embodiments, as may be desired and advantageous for any given or particular application.